Videoinfrastruktur für den verteilten Congress des Chaos Computer Club

FKTG Seminar / Media Event Ilmenau, 23.02.2021

Alexander Votteler & Anton Schubert

Background image by Mitch Altman (Flickr, CC-BY-SA)

Alexander Votteler

- active member of FeM e.V. since 2016
- Chaos Communication Congress Streaming since 2015
- doing freelance work in the video industry
- employed at a local Internet service provider in Aachen

Anton Schubert

- graduation master MT at TU Ilmenau in 2018
- development engineer at Riedel Communications
- active member of FeM e.V. since 2014
- C3VOC streaming since 2014

Forschungsgemeinschaft elektronische Medien

- student association at TU-Ilmenau
- providing Internet access for 2000 students in dormitories
- operation of iSTUFF - a student TV station
- recording of Chaos Communication Congress since 2005

Chaos Computer Club

- CCC is Europe's largest association of hackers
- "galactic community of life forms"
- organized in local communities called "Erfas"

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Chaos Communication Congress

- congress with lectures and workshops surrounding technical, political and social issues
- 2019: 17.000 visitors at Messe Leipzig (36C3)
- organized by volunteers
- 2020: first time as virtual event (rC3)

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C3VOC - "CCC video operations center"

- working group of video enthusiasts in the CCC
- streaming, recording and publishing of lectures
- strong use of open source software and technologies

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Remote Chaos Experience (rC3)

- virtual event in place of the congress
- 27.12.2020 - 30.12.2020
- three main parts

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  - **streaming of lectures**

rC3 Streaming

- 25 studios
- 19 live broadcast channels
- over 350 talks and events

rC3 Streaming

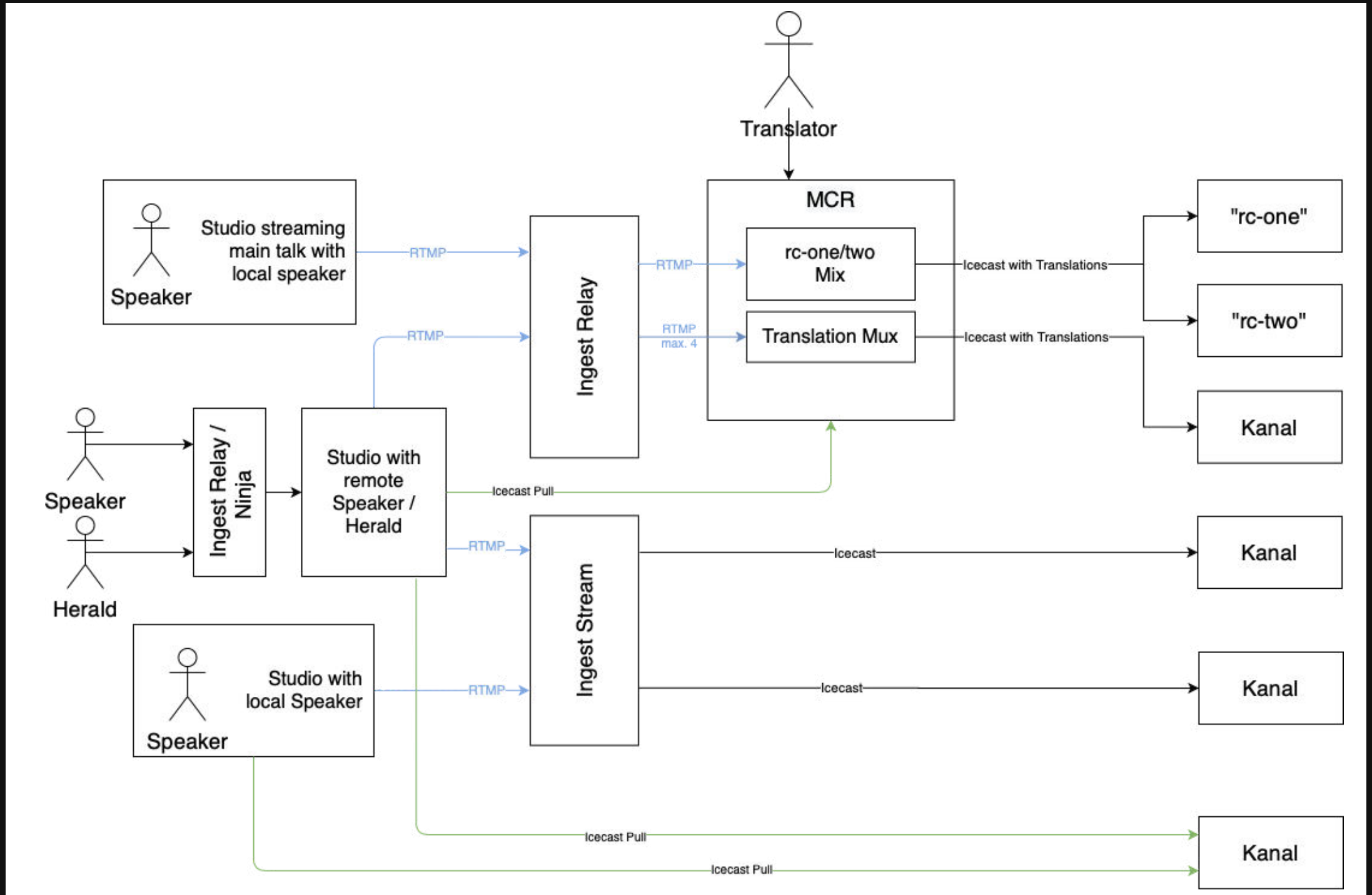
Statistics

- over 9000 peak concurrent livestream viewers
- >25 Gigabit/s peak outgoing stream bandwidth
- about 95% of streams in adaptive formats

rC3 streaming

Community channels

- custom content and streaming schedules
- content produced by local CCC chapters
- streaming and releasing via C3VOCs own infrastructure
- diverse ways of producing video:
  - OBS
  - hardware mixers


Translator
MCR
Studio streaming main talk with local speaker
Speaker
RTMP
Ingest Relay
RTMP
rc-one/two Mix
RTMP
RTMP max. 4
Translation Mux
Icecast with Translations
Icecast with Translations
"rc-one"
"rc-two"
Kanal
Speaker
Herald
Ingest Relay / Ninja
Studio with remote Speaker / Herald
Icecast Pull
RTMP
Ingest Stream
Icecast
Kanal
Studio with local Speaker
Speaker
RTMP
Icecast
Kanal
Icecast Pull
Icecast Pull
Kanal

rC3 streaming

Main channels

- curated content and continuous schedule
- production handled by 12 live studios
- mixing and recording by master control room in Ilmenau

rC3 streaming

Programming Schedule

- studio goes live
  - introduction by herald (announcer)
  - live/prerecorded presentation
  - Q/A session
- handover to next studio

rC3 streaming

Teams

- recording managers
- stream operators (MCR)
- studio crews
- herald crew
- signal angels
- translators
- VOC

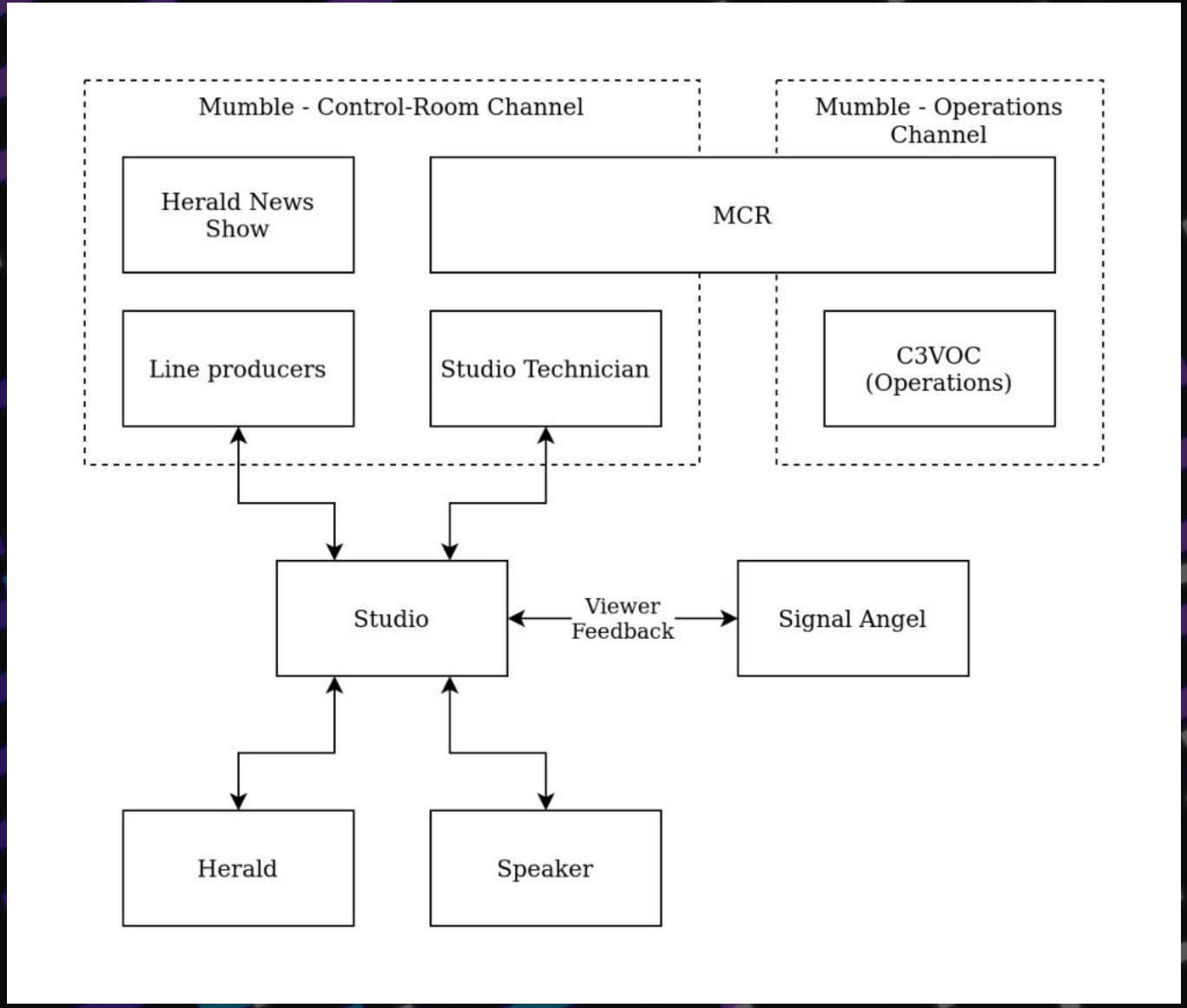
rC3 streaming

Communication channels

- voice communication via Mumble
- shared Kanban boards (Wekan) and ticket system
- file sharing for prerecorded talks

rC3 streaming

Communication channels



rC3 streaming

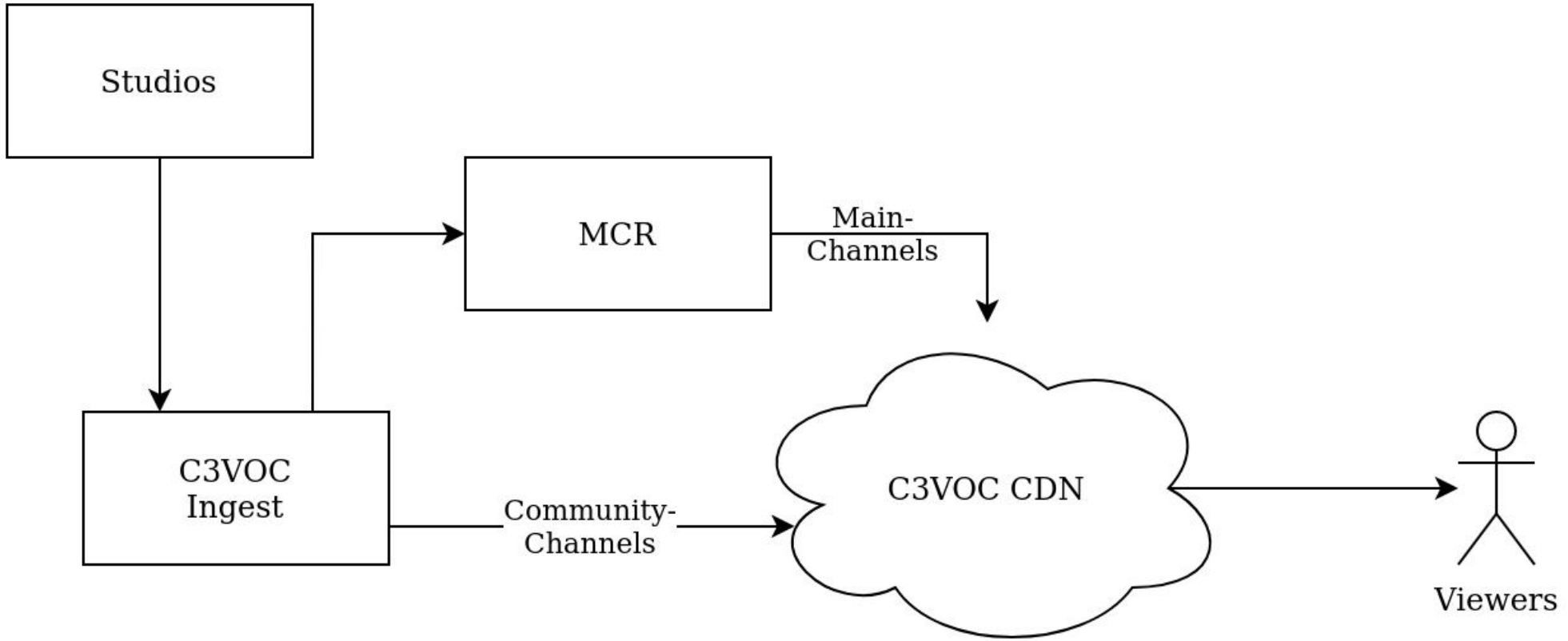
Challenges

- missing live-video experience
- coordinating the chaos
- timing with varying video-delay

Master Control Room

- mixing of the signal for the mains streams
- audio processing
- embedding of live translation

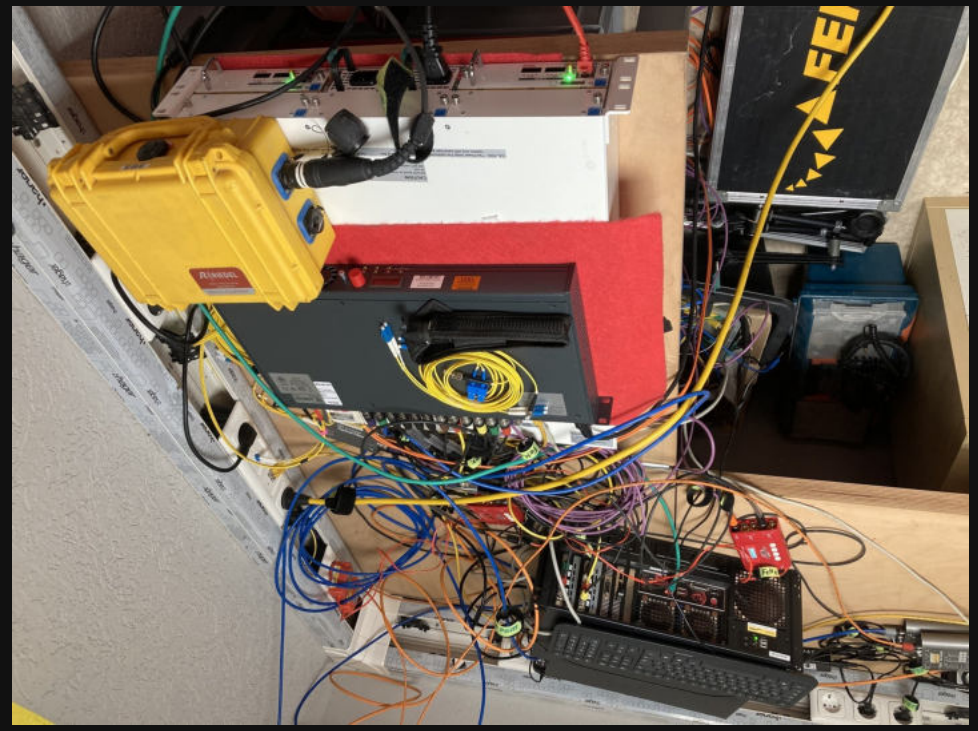
MCR Overview

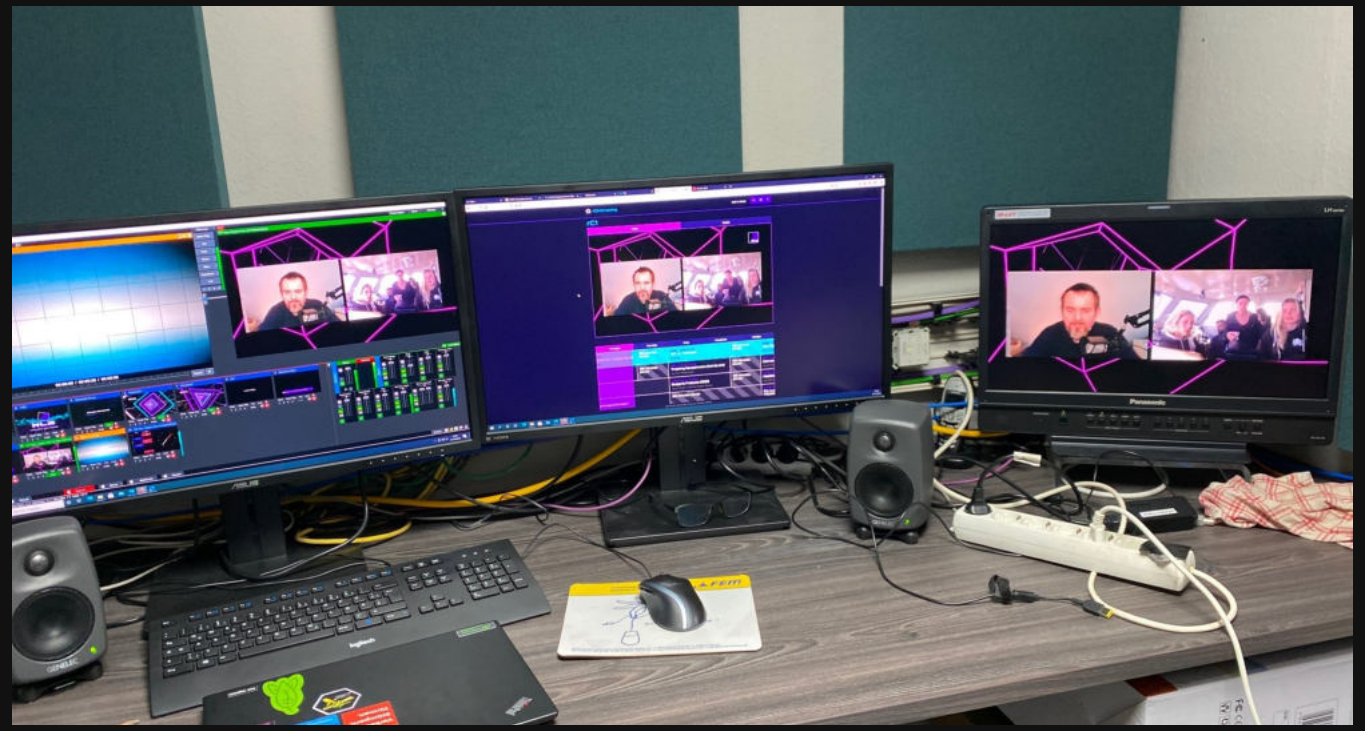


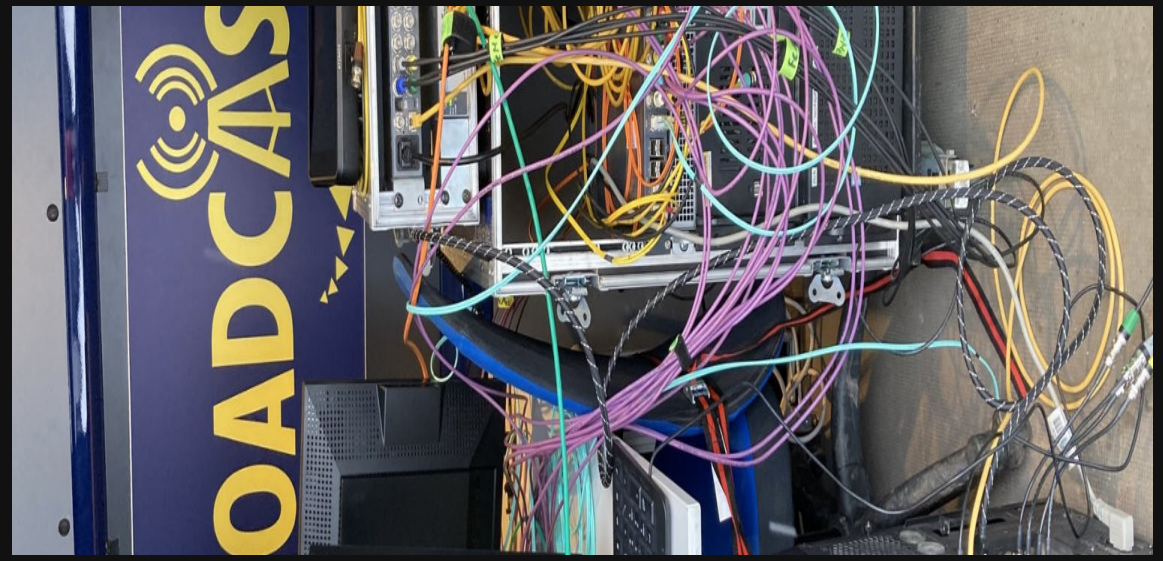
Master Control Room

Equipment

- vMix software video mixer
- Riedel Mediornet
- Lawo V__matrix
- Allen & Heath dLive
- Linux machines with SDI and MADI I/O

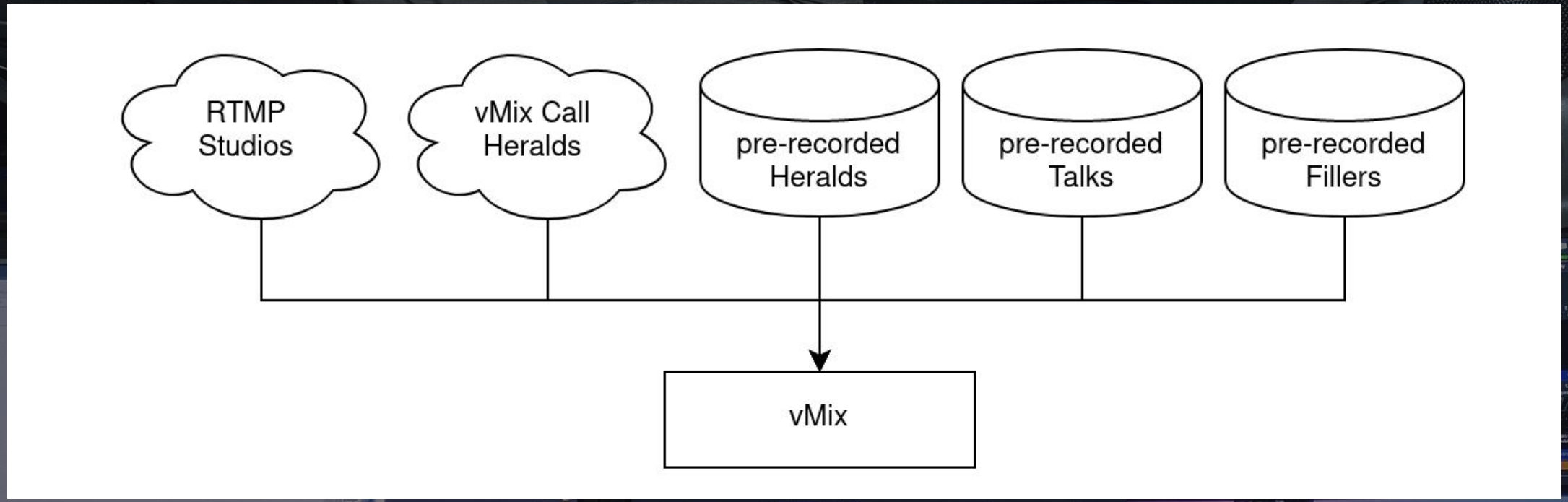






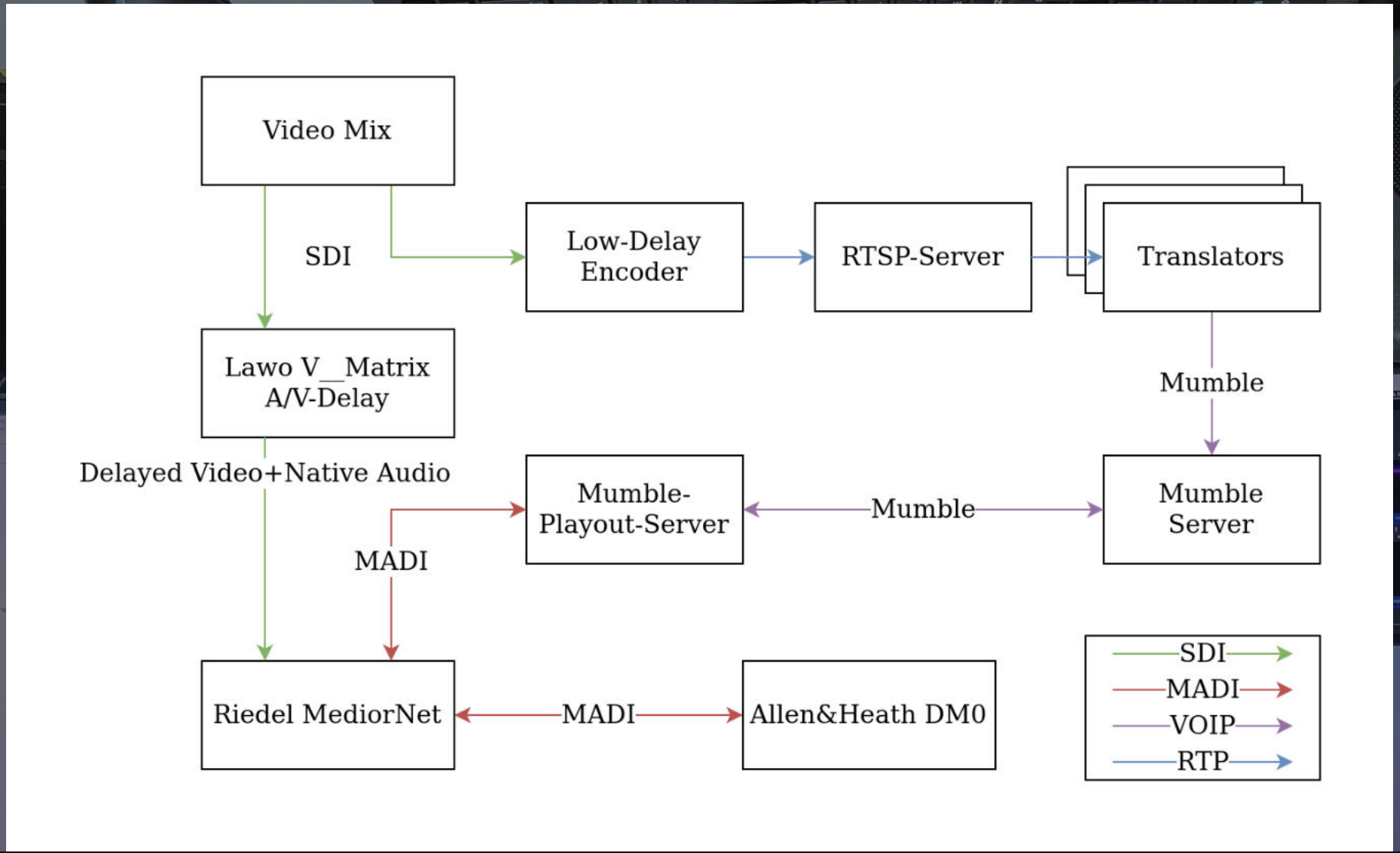
Master Control Room

vMix



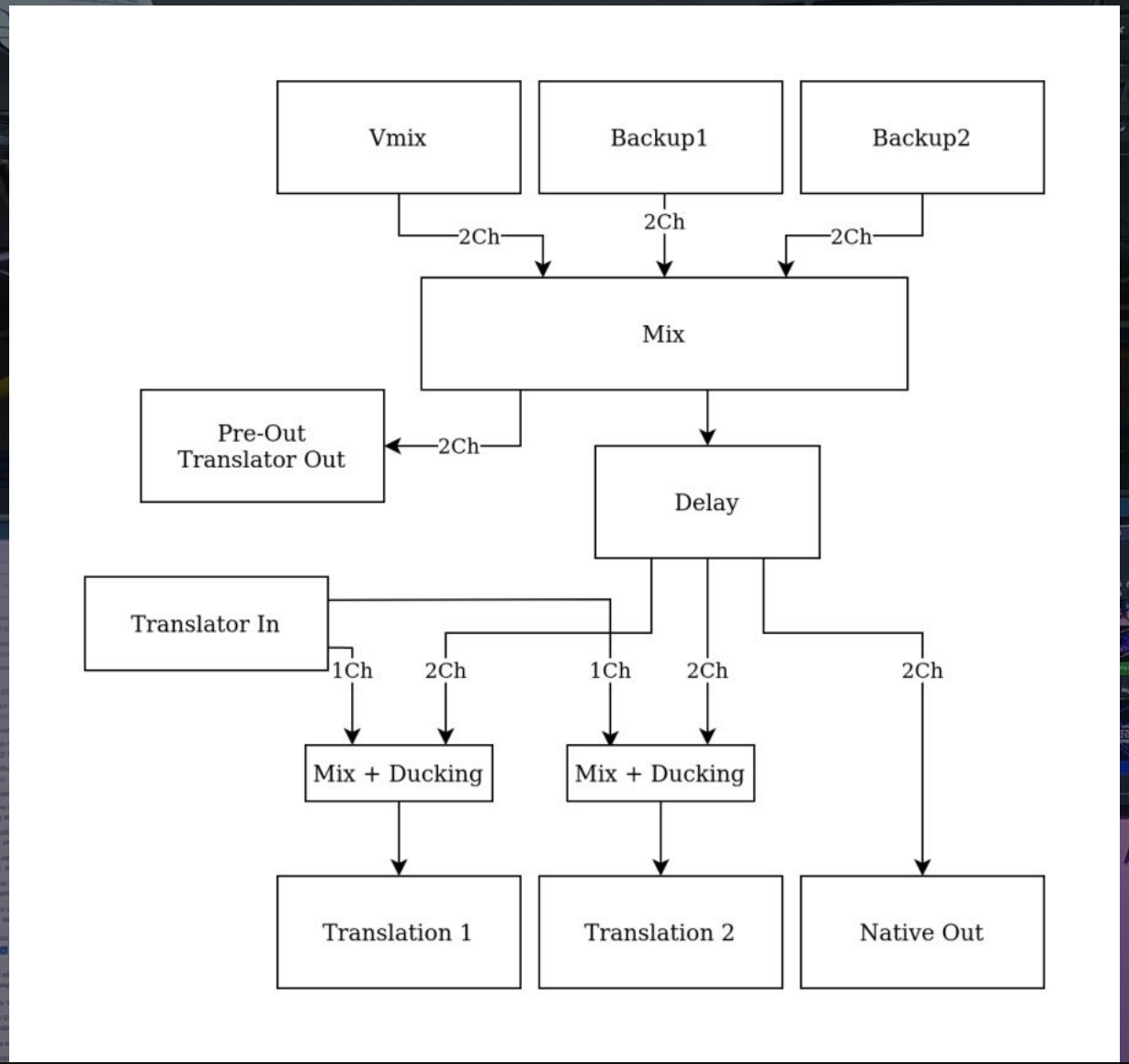
Master Control Room

Translator Ingest



Master Control Room

Audio



Master Control Room

Technical Challenges

- only a single day for building the setup
- SDI interoperability is also bad
- crappy hardware encoders and bad uplinks

C3VOC Infrastructure

Upgrades for rC3

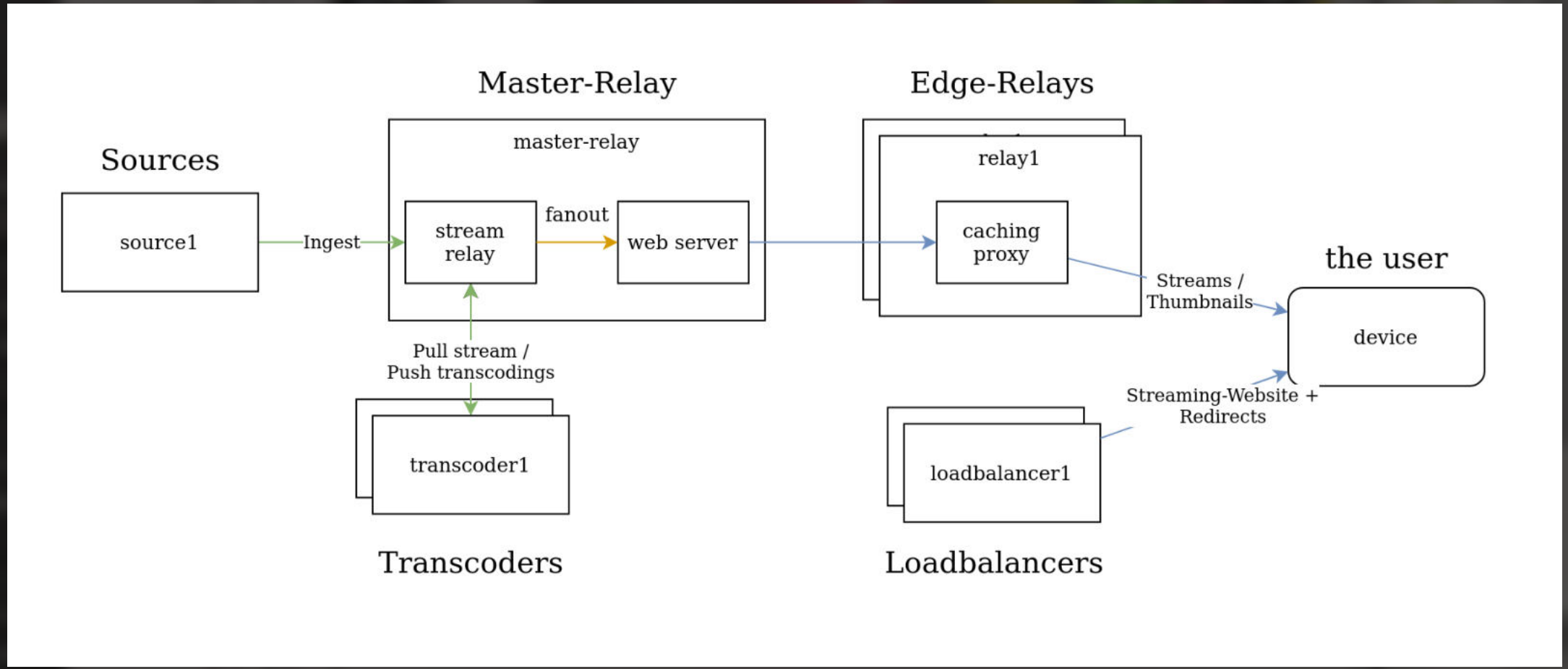
C3VOC Infrastructure

Challenges

- more viewers than before
- greater expectations for the streams
- more streams than before
- production not in hands of the C3VOC

C3VOC Infrastructure

Streaming CDN



Streaming Website

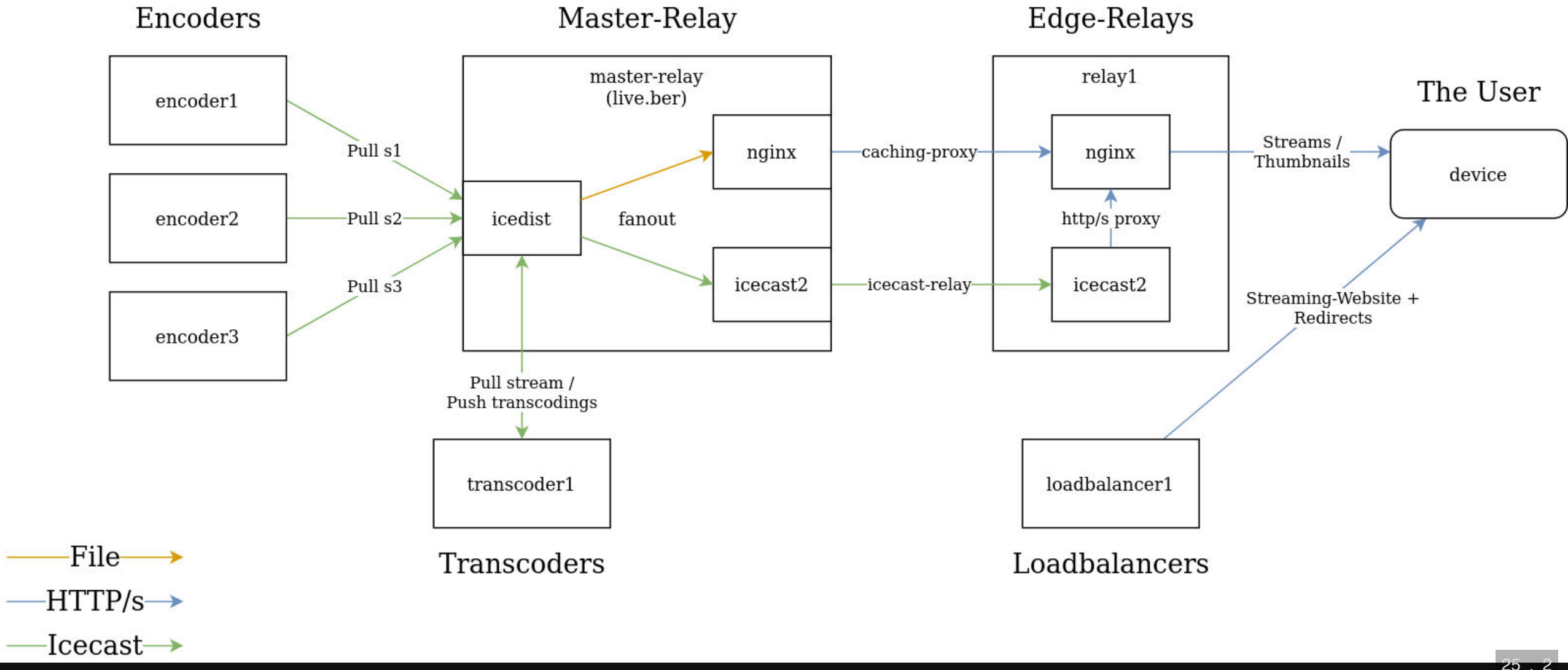
- dynamic Conference schedule
- custom web-player
- Adaptive quality switching
- Multi-Language support
- MPEG-DASH (webM-based) and HLS

C3VOC Infrastructure

Streaming CDN upgrades

- more load-balancers and edge relays
- 80 Gbit/s total CDN bandwidth in 7 locations
- more transcoders
- streaming-capacacity was sufficient
- some ddos on day 2

VOC - CDN


Encoders
Master-Relay
Edge-Relays
The User
encoder1
encoder2
encoder3
Pull s1
Pull s2
Pull s3
master-relay
(live.ber)
icedist
nginx
fanout
icecast2
caching-proxy
icecast-relay
relay1
nginx
http/s proxy
icecast2
Streams /
Thumbnails
device
Streaming-Website +
Redirects
Pull stream /
Push transcodings
transcoder1
loadbalancer1
Transcoders
Loadbalancers
File
HTTP/s
Icecast

C3VOC Infrastructure

Achieving better Stability

- load-testing of CDN edge nodes
- load-testing of software transcoders

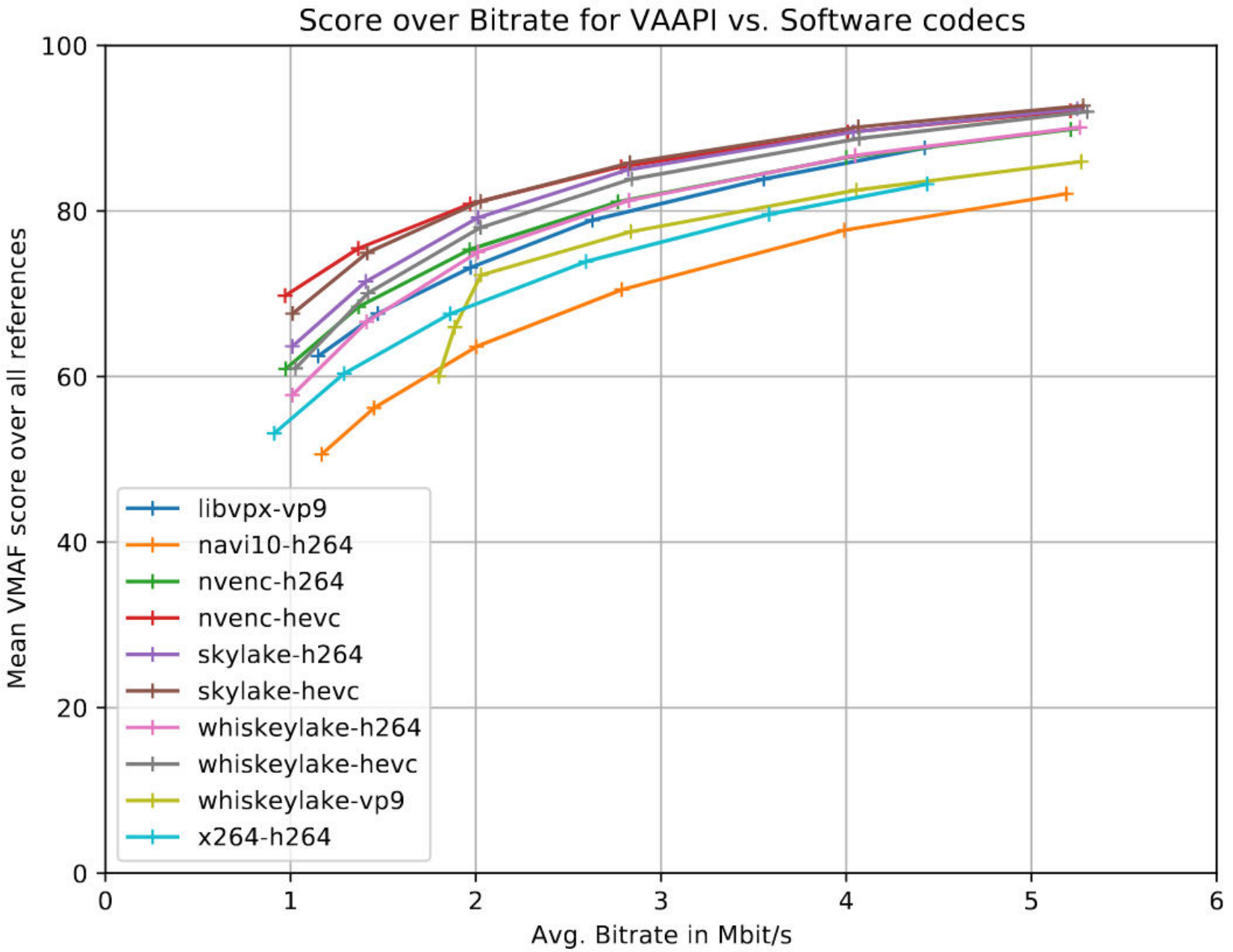
github.com/voc/stream-tools

C3VOC Infrastructure

Encoding h.264 on GPUs

- 2019 first tests with h.264 encoding on Intel GPUs
- 2020 quality comparisons using Netflix VMAF
- Intel h.264 GPU encoding beats x264 for realtime
- using our full hardware: h.264 on GPU, VP9 on CPU

github.com/voc/voctoquality

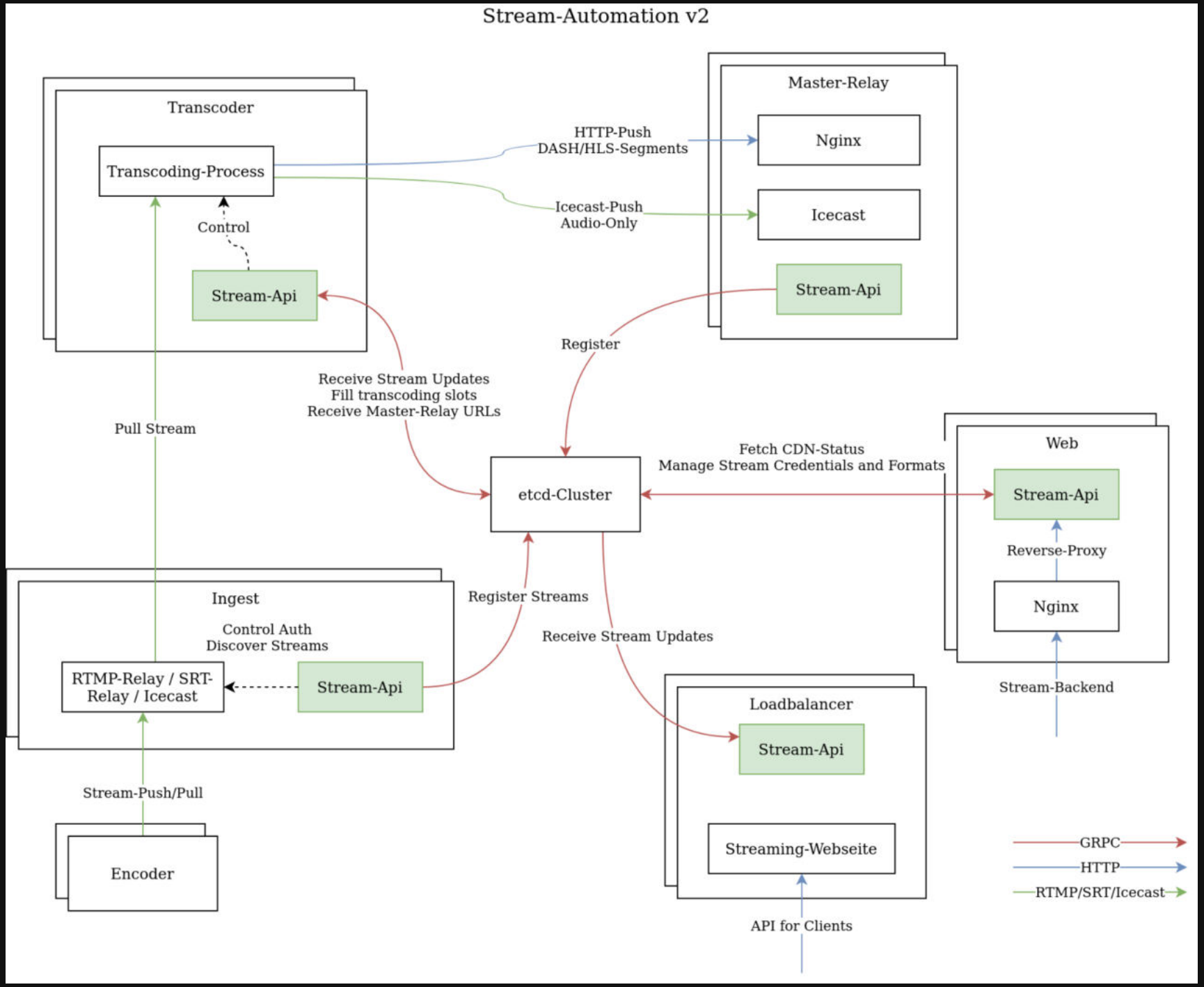

Score over Bitrate for VAAPI vs. Software codecs
Mean VMAF score over all references
Avg. Bitrate in Mbit/s
0
20
40
60
80
100
0
1
2
3
4
5
6
libvpx-vp9
navi10-h264
nvenc-h264
nvenc-hevc
skylake-h264
skylake-hevc
whiskeylake-h264
whiskeylake-hevc
whiskeylake-vp9
x264-h264

C3VOC Infrastructure

Stream Ingest changes

- RTMP is the de facto standard
- used servers with nginx-rtmp plugin
- added a custom authentication backend

https://github.com/voc/rtmp-auth


Stream-Automation v2
Transcoder
Transcoding-Process
Control
Stream-Api
HTTP-Push
DASH/HLS-Segments
Icecast-Push
Audio-Only
Master-Relay
Nginx
Icecast
Stream-Api
Register
Receive Stream Updates
Fill transcoding slots
Receive Master-Relay URLs
Pull Stream
etcd-Cluster
Fetch CDN-Status
Manage Stream Credentials and Formats
Web
Stream-Api
Reverse-Proxy
Nginx
Stream-Backend
Ingest
Control Auth
Discover Streams
RTMP-Relay / SRT-Relay / Icecast
Stream-Api
Register Streams
Receive Stream Updates
Loadbalancer
Stream-Api
Streaming-Webseite
Stream-Push/Pull
Encoder
API for Clients
GRPC
HTTP
RTMP/SRT/Icecast

C3VOC Infrastructure

Getting rid of RTMP

- RTMP is less than ideal
  - only supports one audio-stream
  - limited codec support
  - TCP-based

C3VOC Infrastructure

Getting rid of RTMP

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- so we developed a SRT ingest solution

https://github.com/voc/srtrelay

Future plans

- improve speaker audio/video quality
- make streaming easier for external parties Projects

Projects

- translation muxing in the cloud
- plug&play capable RaspberryPi-based speaker video kit
- custom WebRTC conferencing app (Open Source Vmix Call) (https://github.com/voc/kevin)
- streaming automation and web-based streaming backend

Conclusions

- Mumble Intercom worked great
- check your devices SDI specs
- don't decentralize too much to fast
- testing, testing, testing

Thank you for your attention

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Links:
c3voc.de
github.com/voc/
media.ccc.de/c/rc3

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